

DEATH, TAXES & MOVEMENTS OF DUST ON THE MOON:

REALITY CHECKS APOLLO 11 TO CHANG'E-3 &-4

by

Professor Brian J. O'Brien

<brianjobrien@ozemail.com.au>

University of Western Australia

www.web.uwa.edu.au/person/brian.obrien

PROGRESS IN SCIENCE

EXPLORATION OF THE MOON

- THIS CONFERENCE ASSUMES PROGRESS IN SCIENCE KNOWLEDGE ADVANCES STEADILY IN TIME;
- SO THAT ONE CAN RELY ON ROADMAPS, RELY ON A BASE 2007 REPORT, RELY ON REVIEW & UPDATE, UPDATE SKGs & DISCUSS HERE **FOR NEW REPORT**;
- SCIENCE OF DUST ON THE MOON IS UNUSUAL IN PART BECAUSE THE SCIENCE IS **MOVEMENTS OF DUST**, NOT SIMPLY DUST, BUT DYNAMICS OF DUST;
- ASTRONAUT PROBLEM **MOVEMENT OF DUST** FROM SURFACE **ONTO & INTO** SPACESUITS/WRISTGUARDS

SECOND DIFFERENCE IS SCIENCE IS VERY NEW SHOWN IN 2 KUHN CYCLES

PRE-SCIENCE LUNAR DUST

2014 YUTU IMMOBILISED

1964: RANGER PHOTOS CAUSE DISMISSAL
OF IMPORTANCE OF
BEARING STRENGTH OF DUST
1966: INVENTION OF APOLLO DDE TO
MEASURE CAUSE & EFFECTS OF
MOVEMENTS OF APOLLO DUST
Pre-science

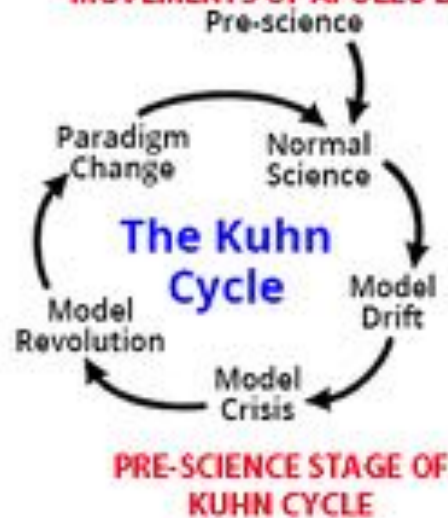


PRE-SCIENCE STAGE OF
KUHN CYCLE

SECOND DIFFERENCE IS THIS SCIENCE VERY NEW SHOWN IN 2 KUHN CYCLES

PRE-SCIENCE LUNAR DUST

1964: RANGER PHOTOS CAUSE DISMISSAL
OF IMPORTANCE OF
BEARING STRENGTH OF DUST
1966: INVENTION OF APOLLO DDE TO
MEASURE CAUSE & EFFECTS OF
MOVEMENTS OF APOLLO DUST



POPULATED 2014-2016

CHANGES IN KNOWLEDGE OF APOLLO DUST 1964-2016

See FIGURE 1 for Pre-science
and DDE the first Paradigm change, Jan. 1966

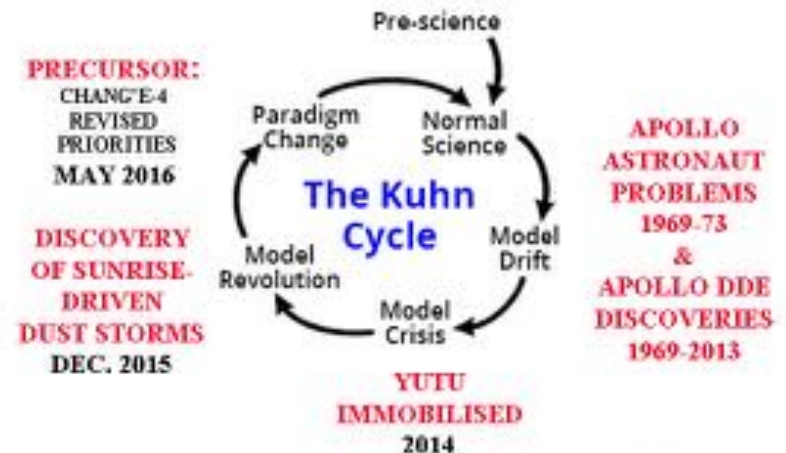


FIGURE 2 STATUS FOR DAP 2017
1 Dec 2017 Brian J. O'Brien

LOOMING PARADIGM CHANGE IN PRIORITY IMPORTANCE OF DUST

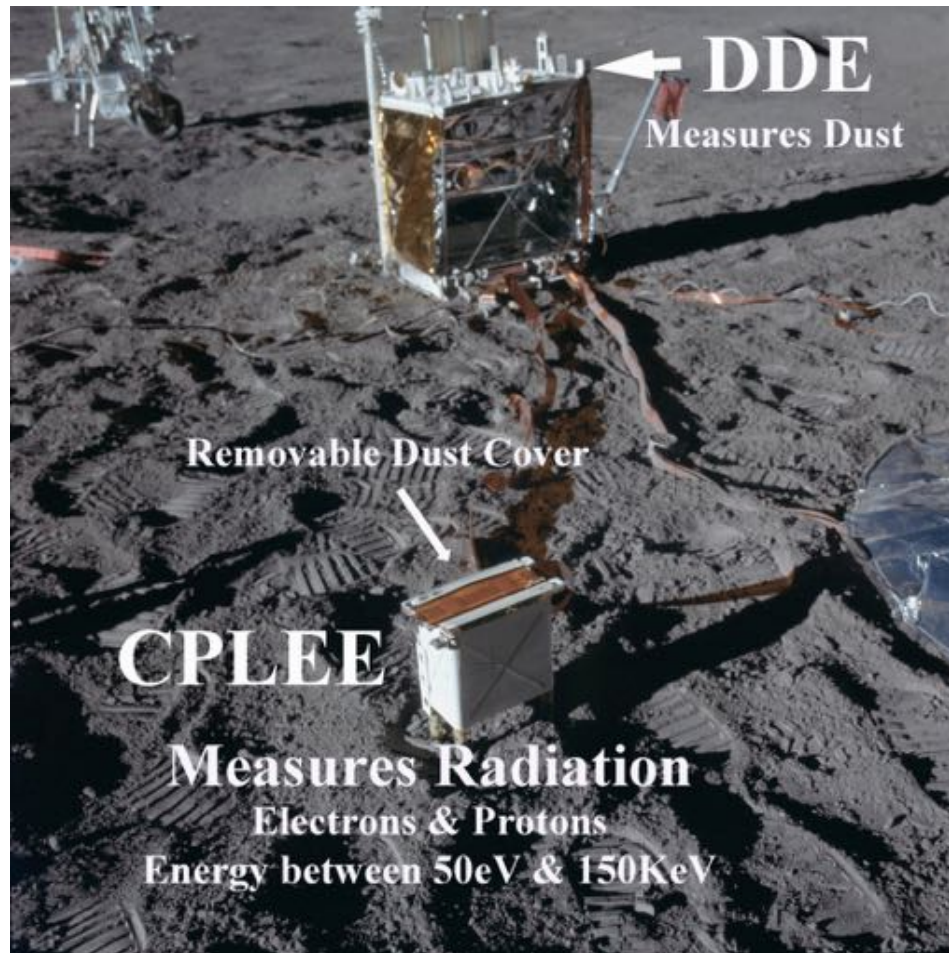
CHINESE PRIORITIES

- AT ELS 2016, ZOU Y.L ET AL. REPORTED PRIORITIES OF CHANG'E-4 IN 2018 HAVE CHANGED TO GIVE TOP PRIORITY TO DUST – FIRST LANDER TO DO SO
- AS OF DEC 2017, NOT YET CONFIRMED BUT VARIED OPAQUE COMMUNICATION

USA APOLLO MINDSETS

- **IN 1964** APOLLO MINDSET “DISMISSED” THE IMPORTANCE OF DUST (SEE NOEL HINNERS, NASA ORAL HISTORY 2010);
- **CONTRARY** TO APOLLO 17 SEVERE DUST PROBLEMS DESPITE TECHNOLOGY & MANY ASTRONAUT REPORTS OF PROBLEMS

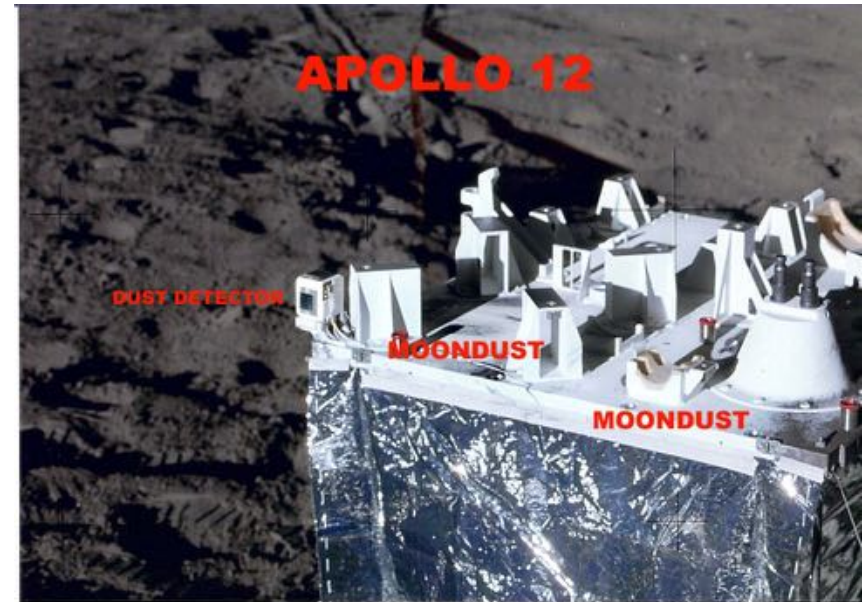
SERENDIPITOUS INVENTION OF APOLLO DUST DETECTOR (DDE) IN 1966 IS 8th ALSEP EXPERIMENT: INITIALLY RISK MANAGEMENT OF BRIAN'S CPLEE



APOLLO 12 DUST DETECTOR EXPERIMENT (DDE)

CALIBRATED UNIT IN 1968

APOLLO 12 DDE ON MOON
NOTE SPLASHES OF MOONDUST



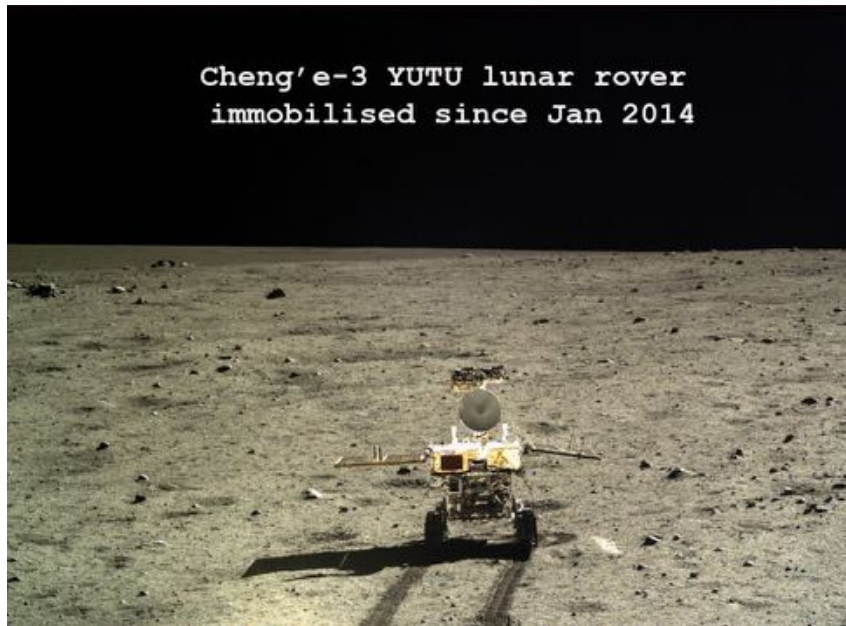
HOW DOES DUST DETECTOR EXPERIMENT (DDE) WORK?

- **3 ORTHOGONAL SOLAR CELLS FACE EAST WEST & UP**
- **THERMOMETER ON BACK OF EACH CELL**
- **SO MEASURES BOTH CAUSE & EFFECT, TOTAL SYSTEM**
- **CELL VOLTAGE VARIES WITH SUNLIGHT, COMPUTABLE**
- **SIMPLER CAN USE CHANGES TO MEASURE MOVEMENTS**
- **DUST ON CELL CAUSES % CHANGE IN VOLTAGE WHICH IS FUNGIBLE, ANY RESEARCHER WITH A PREFERENCE FOR A GIVEN DUST JUST DROPS IT ON HIS OWN CELL TO MATCH %;**
- **COST CIRCA \$50, APOLLO RECORD 6 YEARS CONTINUOUS;**
- **PARADIGM SHIFT IN DESIGN, MEASURING MOVEMENTS OF BILLIONS TO TRILLIONS OF PARTICLES, NOT ONE AT A TIME.**

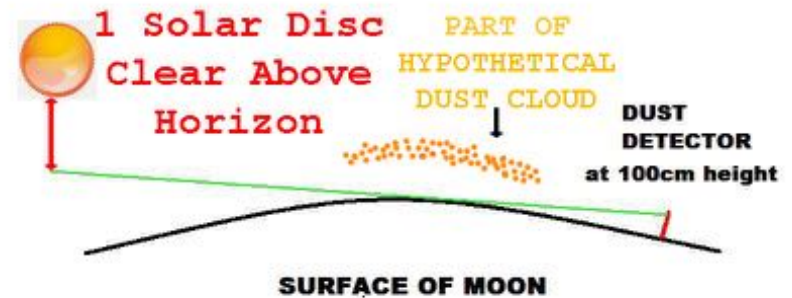
YUTU PUZZLE SOLVED (?) BY APOLLO 12 DDE SUNRISE EFFECT

CHANG'E-3 YUTU STOPS
AFTER 1st SUNRISE 2014

DDE MEASURES SUNRISE
CAUSES DUST STORMS
(SHOWN AT AMES 2009)



APOLLO 12 POST-SUNRISE "EVENT"



© Copyright Brian J. O'Brien 2009

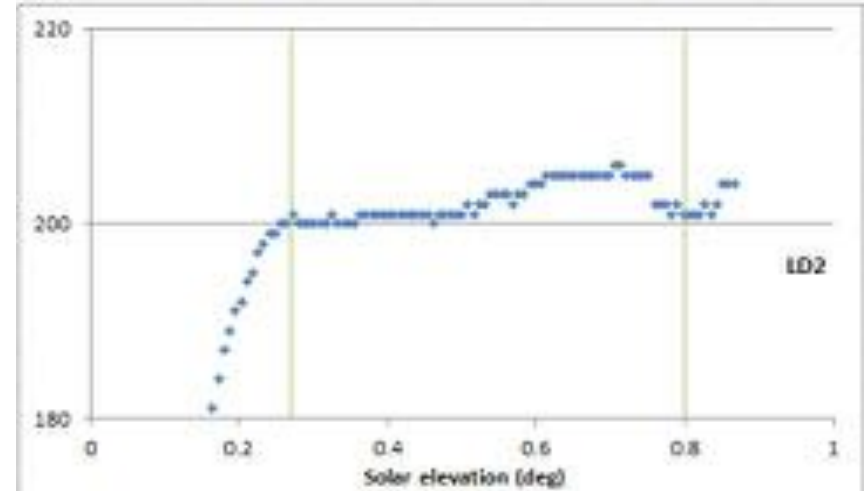
TRANSPARENCY & DUST EFFECTS

**YUTU-RELATED PAPER
WITHDRAWN 2017**

**PRESENTATION OF CHANG'E-3
MEASUREMENTS OF DUST
WITHDRAWN AT ADELAIDE
2017,
ABSTRACT ON IAC 2017
WEBSITE**

**APOLLO TRANSPARENT
IN 21st CENTURY**

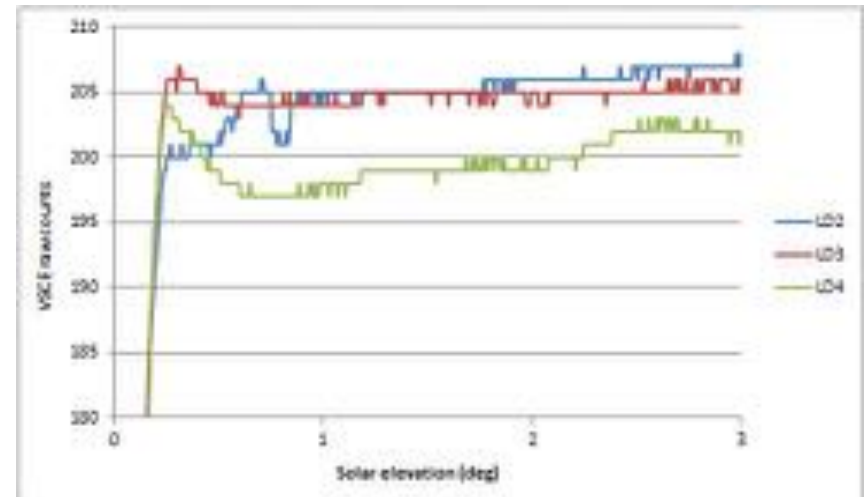
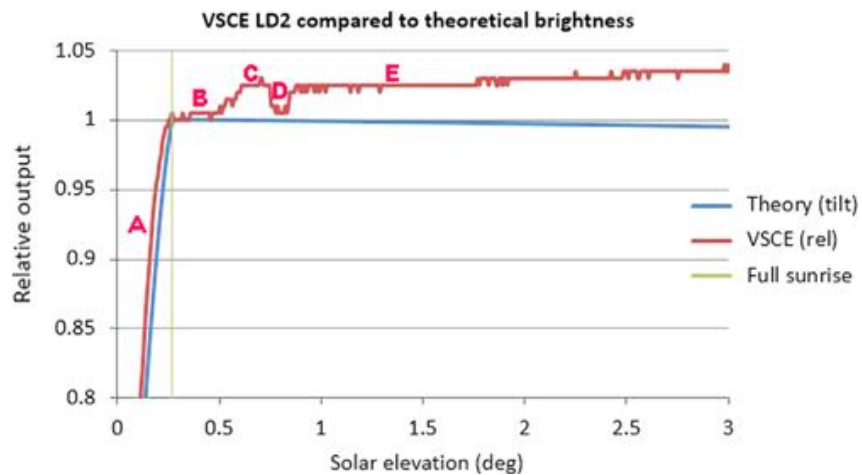
**(BUT REJECTIONS IN 1969-70
OF BRIAN'S FIRST REPORTS
ON SUNRISE EFFECTS)**



SUNRISE HORIZON BRIGHTENING & DUST STORMS

APOLLO 12 DDE **1st SUNRISE**

APOLLO 12 DDE **LD2, LD3, LD4**



HOW RELEVANT TO PLANNING ARE 14 PEER-REVIEWED DUST DISCOVERIES?

**CONFIRM ASTRONAUT VIEWS
FOR HIGHEST REALISM (SEE
NEXT SLIDE FOR DETAILS)**

- **NEED NOW FOR ROOT &
BRANCH REMOVAL OF
1964 MINDSETS
DISMISSING IMPORTANCE
(SEE NOEL HINNERS: NASA
ORAL HISTORY 2010).**

3 SENSITIVE ISSUES

- 1. STRONG POPULARITY OF
POLAR LANDING SITES:
HAVE MOVEMENTS OF DUST
AT **LOW SOLAR ELEVATION**
BEEN FACTORED IN YET?**
- 2. HERITAGE ASPECTS AND
SUSTAINABILITY**
- 3. COMMERCIAL INTERESTS
IN COST-EFFECTIVENESS:
DUST DELAYED ASTRONAUTS**

ASTRONAUT PRIORITIES OF DUST

GAIER (2005) REVIEW

- Equipment was clogged and mechanisms jammed in every Apollo mission. Including zippers, wrist and hose locks, faceplates and sunshades.
- The most alarming was how quickly and irreversibly this could happen.

DIRECT QUOTES

- Cernan Debriefing:
- “(Dust) probably one of our greatest inhibitors to a nominal mission”;
- **“..WE CAN OVERCOME OTHER PHYSIOLOGICAL OR PHYSICAL OR MECHANICAL PROBLEMS EXCEPT DUST”**
- YOU HAVE TO LIVE WITH .. CONTINUALLY FIGHTING ... DUST

QUICK-LOOK SUMMARY: DUST AS A FACTOR IN SITE SELECTION

SUMMARY FROM APOLLO

1. APOLLO DDE DATA ARE FROM APOLLO 11, 12, 14 & 15 SITES;
2. WE HAVE NOTHING FROM DUST FACTORS TO RIGOROUSLY CONTRIBUTE DIFFERENTIATING THEM;
3. WE RATE FAR SIDE AS VERY HIGH PRIORITY, RICHEST IN KNOWN & UNKNOWN UNKNOWN.

SPECULATIONS

- VARIOUS DUST DISCOVERIES REMAIN UNEXPLAINED BY THEORIES;
- UNCERTAINTIES REMAIN ABOUT SUNLIGHT BRIGHTNESS ALTERING ADHESION TO VERTICAL SURFACE (1 example only).

POSSIBLE STRATEGIC IMPORTANCE OF DUST MOVEMENTS TO LUNAR POLAR EXPEDITIONS

- **APOLLO 12 DDE MEASUREMENTS SHOW DUST-CAUSED VARIATIONS OF DAWN LIGHT OF 1 TO 4% AT LOW SOLAR ELEVATIONS**
- **RESEARCHERS MIGHT REVIEW IMPLICIT ASSUMPTIONS OF DUST PLAYING NO ROLES ON PLANS FOR POLAR EXPEDITIONS OR**
- **MOUNTAINS OF ETERNAL LIGHT**

HERITAGE MANAGEMENT, DUST & COST EFFECTIVENESS

- **Margaret Race & Commercial entrepreneurs discuss managing heritage and sustainability**
- **14 discoveries to date provide only dust measurements of movements to date from:**
 - **(a) human and robotic activities**
 - **(b) from Natural phenomena e.g. sunrise effects & for 6 years**
- **Dust management vital in cost effectiveness**

COMMERCIAL ISSUES & COST EFFECTIVENESS

PRIVATE FIRMS' REVOLUTION

- INDUSTRIES NEED SUSTAINABILITY & LOCAL RESOURCES
- LUNAR DUST & SUNRISE EFFECTS ANSWER BOTH
- NATURAL PROCESSES AT SUNRISE RETURN MINED SURFACE TO OPTICAL SMOOTHNESS, COHESION
- RELY ON COHESIVE FORCE

DENIALS BY LUNAR SCIENCE

- APOLLO 14 PSR 1972
TOMMY GOLD WITH TDS DISCOVERED COHESIVE FORCES OF DUST (see next)
- DISCOVERY IGNORED FOR 40 YEARS UNTIL O'BRIEN (2011);
- TDS EXPERIMENT RETURN TO HOUSTON, PUT IN QUARANTINE & LOST.

LUNAR SCIENTISTS 1972-2015: IGNORED TOMMY GOLD COHESIVE FORCES



O'BRIEN PURPOSES IN 1966-67

ALL 7 PIs GET LUNAR DUST DATA

IN 2009-2010 O'BRIEN RE-PUBLICISED SUCH FACTS

SHARED DDE DATA ALSEP

- **O'BRIEN & BENDIX ORGANISED ALSEP TELEMETRY TO ENSURE EACH ALSEP PI GOT ALL 6 CHANNELS OF DDE RAW DATA INCLUDED IN HIS OWN INDIVIDUAL PI COMPUTER DATA TAPES**
- **IN WORD 30 COMMUTATED ENGINEERING & HOUSEKEEPING**
- **2009 WITH NASA HQTRS AND JSC AT HIGH LEVELS**
- **AT NASA AMES JULY 2009 WITH YOSIO NAKAMURA**
- **YOSIO & BRIAN 2009-10 FORMATTED DDE RAW DATA YOSIO 1991 TAPES**
- **ON-SHARING WITH NSSDC VIA YOSIO ALL DUST DATA**

LONG-STANDING ARTEFACTS OF FUTURE PLANNING, SKGs & SITE SELECTIONS, MAY REQUIRE NEW REVIEWS BECAUSE OF OUTDATED MINDSETS ON DUST

ASTRONAUTS

- **GENE CERNAN (Debriefing 1972)"We can overcome (all problems) except dust"**

GEOLOGISTS

- **VAST MAJORITY OF SCIENCE GROUP & MAY REGARD DUST ONLY AS NUISANCE**

**ADMINISTRATION:
Noel Hinners NASA
Oral History 2010**

(N.B. UPDATE RE COHESIVE FORCES)

- **1964 RANGER PHOTO SHOWED BIG ROCK SITTING "CALMLY ON THE SURFACE AND NOT SINKING OUT OF SIGHT", SO WE "DISMISSED THAT (DUST) CONCERN ALTHOUGH TOMMY GOLD KEPT AT IT...WE HAD TO DEAL WITH HIM."**

LEAVE OPEN FOR RICKY GUEST

13 DEC. WASHINGTON POST

VIDEO

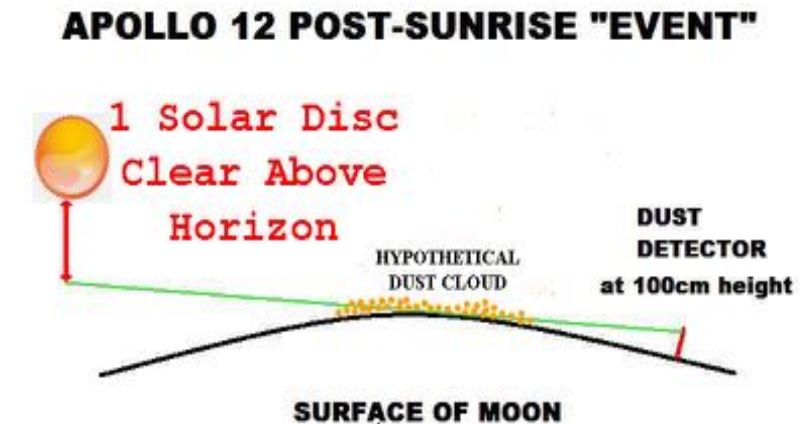
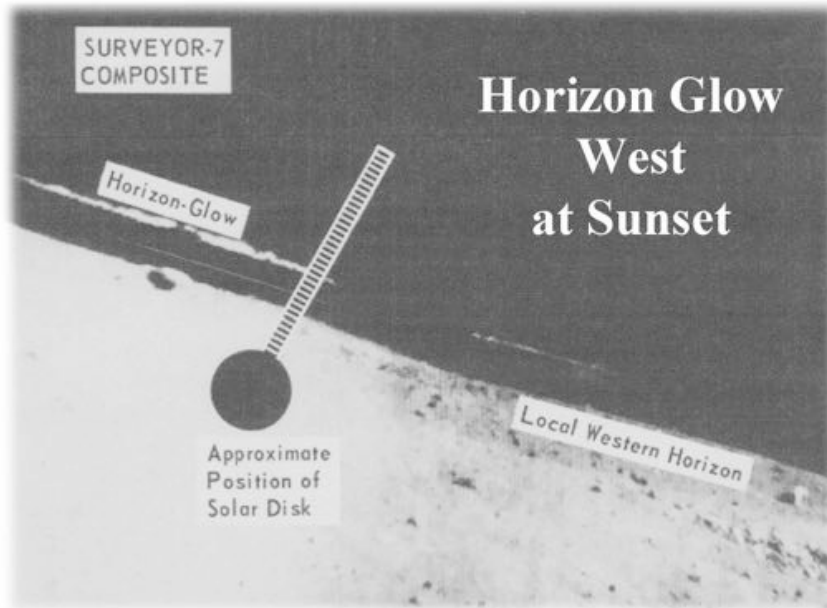
- http://www.washingtonpost.com/video/national/health-science/apollo-17-left-the-moon-45-years-ago-that-dirty-space-gear-has-a-story-to-tell/2017/12/13/004583cc-e01e-11e7-b2e9-8c636f076c76_video.html

THINK TEST on HORIZON GLOW

IF DUST HEIGHT IS 100cm (as in DDE)

**SURVEYOR 7 "AT" SUNSET:
IS DUST IN DAY OR NIGHT?**

**APOLLO 12 DDE HORIZON
BRIGHTENING AFTER SUNRISE**



© Copyright Brian J. O'Brien 2009

5-STEP O'BRIEN MODEL

1. **COHESIVE FORCES** SMOOTH SURFACE;
 2. ROCKET GASES UNDER SURFACE FREE DUST;
 3. **FREED DUST MOBILISES** WHEN CHARGED BY MASSIVE SUNRISE PHOTO-ELECTRIC EFFECTS
 4. COULOMB FORCES **LEVITATE FREED** DUST;
 5. DURING EACH LUNAR NIGHT SOME DUST FALLS & RECAPTURED BY COHESIVE FORCES
- CIRCA 1 TO 2 YEARS BEFORE OPTICAL SMOOTH